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CITATION:

ICHIKAWA, Mitsuo. The Forest World as a Circulation System: The impacts of Mbuti Habitation and Subsistence Activities on the Forest Environment. African study monographs. Supplementary issue 2001, 26: 157-168

ISSUE DATE:

2001-03

URL:

<https://doi.org/10.14989/68402>

RIGHT:

THE FOREST WORLD AS A CIRCULATION SYSTEM: THE IMPACTS OF MBUTI HABITATION AND SUBSISTENCE ACTIVITIES ON THE FOREST ENVIRONMENT

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ABSTRACT While the dependence of Mbuti hunter-gatherers on the forest is relatively well documented, it has not been made clear how their activities and habitation influence the forest environment in which they live. The analysis of distribution of food plants and human induced secondary forests in the Ituri Forest of Congo suggests that the forest as a hunter-gatherer habitat may have been improved by the interaction of Mbuti hunters, Bantu and other farmers, plants and animals. Most of the major food plants of the Mbuti are light-demanding trees which grow well in secondary and disturbed vegetation regenerated from abandoned campsites and fields. The food plants also germinate from the discarded food thrown around the campsite. Moreover, large quantities of minerals and organic matters are concentrated to the camp as food and fuels, which, after the consumption, are accumulated also around the campsite in the forms of ashes and human body wastes, thus enriching the soil nutrients in the vicinity of the camp. The Mbuti activities and habitation thus comprise a part of a large recycling system of the forest ecosystem. The implications of such positive human impacts on the forest environment for conservation and development issues are discussed.

Key Words: Forest ecosystem; Human impact; Concentration effect; Recycling system

INTRODUCTION

It is often emphasized that human activities or his mere presence in the tropical rain forest impose destructive impact on the forest environment. According to this view, it is only because of their low population density and limited pressures on the forest and its resources, that this destructive impact had not become serious until recently.

If we take such a negative aspect of human impacts in consideration, we are tempted to design a plan in which land use is separated in two ways; that is, to establish a so-called wildlife sanctuary where all kinds of human activities are excluded on one hand, whereas on the other hand to promote development programs in other areas. The land use, or resulting landscape of the area, would thus be polarizing or bifurcating in the future into the area that is totally protected and the area for promoting development project. Such a polarization of landscape might be inevitable in certain areas where tropical forests are rapidly disappearing. It should be noted, however, this is a sort of realization in landscape of the dichotomy of the

modern Western thought between nature (as represented by wildlife sanctuary) and culture (as represented by development areas).

In the idea of wildlife sanctuary, we also find a lack of understanding of the interactive process between man and the nature. We have noticed, for example, through our study on the forest peoples in Africa that, human habitation and their activities have also potentials to improve the forest environment as a human habitat, whether this is accomplished intentionally (with some forest management plan) or not. I will discuss below on such positive human impacts on the forest environment, with special reference to the Mbuti hunter-gatherers in the Ituri forest of former Zaire, now called the Democratic Republic of Congo.

In early 1970's, after the Colin Turnbull's last visit to the Ituri forest, we started the research on the Mbuti by an ecological method in its broad sense, and investigated their natural environment, subsistence activities, diet, demography, social organization, and ethno-scientific knowledge concerning plants and animals in the forest. One of the problems emerging from these studies is that we have yet to know more about how these people depend on the forest and its resources. As is often stated, these forest people have surprisingly rich knowledge on the forest fauna and flora. One of our major interests is therefore to describe, and preserve in some way such a unique culture based on the rich forest environment. We have been engaged in the AFlora project, that is to compile a database on the use of plants in tropical Africa (see also, Terashima et al., 1991).

Another problem is that, while they depend heavily on the forest, the forest itself is in a sense a historical product, which has been maintained through the interaction between man and the environment. It is important therefore to see the local ecosystem as such an interdependent system of man and forest. This notion has lead us to the interest in historical ecology, that is, the history of interaction between man and environment.

IMPORTANCE OF SECONDARY VEGETATION

Before proceeding to the problem of human impacts on the forest environment, let us first have a brief look on how they use the forest and its resources. While the Mbuti have a relationship with the forest in diverse and multiplex ways, one of the best examples to illustrate this is to look at the use of plants. The forest plants are used in direct ways for food, medicine, rituals and material culture, as well as in indirect ways such as for bee plants (source of honey) and foods of game animals. Most, if not all, of the forest plants are used, either directly or indirectly, for material as well as spiritual purposes. The forest plants are thus indispensable to the Mbuti's life, and they provide the Mbuti with the basis of their cultural identity (Ichikawa, 1996).

However, the Mbuti are not merely benefited by the forest and its resources. They are also contributing to maintaining the forest resources through their activities. In the ethnobotanical study among the Mbuti, we are particularly interested in the distribution of wild food plants in the forest. While they depend more than 60 % of their food intake on agricultural products, there are also important

Table 1. Habitats of important food plants.

Species	Habitat (source)
Nuts and seeds	
# <i>Antrocaryon nannani</i>	old secondary forest (1,2)
<i>Gilbertiodendron dewevreii</i>	evergreen forest (3)
<i>Irvingia robur</i>	evergreen forest (4)
<i>Irvingia gabonensis</i>	evergreen forest and mixed deciduous forest (4,5)
# <i>Ricinodendron heudelotti</i>	deciduous and secondary forest (3,5)
<i>Treculia africana</i>	evergreen and deciduous forest often by stream (5)
# <i>Tetracarpidium conophorum</i>	low bush (5)
Fruit and berries	
# <i>Elaies guineensis</i>	secondary forest and abandoned fields (1,3)
# <i>Canarium schweinfurthii</i>	secondary forest, regenerating only in gaps and roadside (2,6)
<i>Anonidium mannii</i>	closed forest (5)
# <i>Landolphia owariensis</i>	deciduous and secondary forest (5)
Tubers and bulbils	
# <i>Dioscorea praehensilis</i>	secondary forest, often on rocky hills (1,4), regenerating in shade but growing best in forest margins and gaps (6)
# <i>Dioscorea bulbifera</i>	secondary forest and abandoned fields (1,4)

#: Indicates that the species is mainly found in secondary or disturbed vegetation.

Source: 1) Observation by Ichikawa; 2) UNESCO, 1983; 3) T. Hart, 1985; 4) Hart and Hart, 1986; 5) Irvine, 1961; 6) Hall and Swaine, 1981.

wild plant food species eaten almost every day during their seasons. The examination of the habitats of these wild food species reveals that many of these are light-demanding plants which require sufficient light either for germination or for growth (Table 1). The nut-producing *Antrocaryon nannanii* and *Ricinodendron heudelotti* are the examples of such sun trees. While they form today one of the big canopy trees, they must have germinated and grown in the habitat where there was sufficient light. The sweet fruit-bearing liana of *Landolphia* spp. is said to grow best on forest margins or in disturbed areas. *Dioscorea* spp. also require sufficient light for accumulating starch in the tubers which are one of the Mbuti's important foods. Where a big *Canarium* tree is observed in the forest, it is said people once inhabited there, forming either village or campsite.

These plants must have grown in the "gaps" (open places made by the fall of canopy trees) where sufficient light reached to the ground.

Moreover, there are in fact more plant food species in secondary forests than in so-called primary forests, as mentioned later. While these facts have already been pointed out by American ecologists Drs. John and Terese Hart (1986), we

are particularly interested in its implications for understanding historical ecology, a history of interaction of man and forest, in the area.

In the primary forest, there are usually scattered gaps made by storms, lightening and other natural causes. While walking in the forest in the end of rainy season, I once observed 5 such gaps in an hour walk in the forest.

This means that such newly formed gaps are found for every km in the forest. In these gaps, fast-growing sun trees will germinate and soon form the secondary forest, from which the vegetation of a primary forest will be gradually recovered. The actual forest shows, therefore, a mosaic structure, consisting of the vegetation types of different succession stages, from newly formed gaps to secondary and mature forests.

HUMAN IMPACTS ON THE FOREST VEGETATION

In addition to these gaps formed by natural causes, there are also traces of human activities in the Ituri forest. One of such examples is honey collecting. They usually collect honey from an opening cut on the tree, but when it is difficult to climb and collect the honey, they sometimes cut down the whole tree with an ax. In this case, a gap, similar to the natural one, is made artificially.

When the Mbuti opens a new camp, they clear the underbrush and small to medium-sized trees, which allows sunlight to reach to the ground. When the camp is abandoned, herbaceous plants of Zingiberaceae and Marantaceae grow rapidly, followed by light-demanding, fast-growing tree species. The long-term campsite of the Mbuti will be covered with the secondary vegetation similar to that regenerated from natural gaps, shortly after its abandonment.

Also found in the old campsite are seedlings germinated from the food waste, like those of *Treculia*, *Landolphia* spp. and *Canarium schweinfurtii*. Germination of *Landolphia* seeds, in particular, is facilitated by human intervention, in that they scatter the seeds in sunny or disturbed places and that seeds excreted from a digestive tract germinate more easily.

Moreover, large quantities of minerals and organic matters are concentrated to the campsite in the form of food, fuels and other resources which are collected from a wide range of forest and consumed at the camp. Human activities and habitation thus contribute to concentrating otherwise thinly distributed material to the campsite. The soil nutrients of a campsite and its surrounding area are therefore enriched with the organic matters and minerals supplied by these food remains, ashes and body wastes.

While there are hardly reliable data available for assessing such a concentration effect of human habitation, Nishida (1997) estimated, for example, the amount of nutrients in the food and fuels consumed in a year by 25 Japanese prehistoric hunter-gatherers to be 400 kg of nitrogen, 200 kg of phosphorus, 70 kg of potassium and 110 kg of calcium. These are almost equivalent to that of the fertilizers used for a chestnut orchard producing 10 tons of chestnuts annually (see also Nishida, this volume). In a Mbuti camp, a household composed of 5 persons use 10 to 15 kg of firewood per day. The firewood consumed by 10 households, or 50 people,

Table 2. Nutrients in the food and firewood consumed at a forest camp.

Materials	Total consumption (kg/50 persons/month)	N	P
Food	1,500	12.5	8.3
Firewood	3,000	7.8	1.5
Total		20.3	9.8

Note: The amounts of N and P in the food are equivalent to those in 200-250kg of ammonium sulphate.

which is the average size of a Mbuti camp, during a month period, thus amounts to 3 to 4.5 tons, and the ashes from the firewood are deposited around the campsite. There are also minerals and organic matters supplied from the food (Table 2). While all of these are not absorbed by the soil (in particular, most of the nitrogen from the firewood goes to the air), but the nitrogen and phosphorus supplied from the food, as human manure, alone amount to 12.5 kg and 8.3 kg, respectively. This is equivalent to at least 200 kg of ammonium sulfate.

Thus, a campsite and its surrounding area provide a favorable place for the recycle or reproduction of the food resources, first by improving light conditions, second by supplying seeds and other reproductive resources, and thirdly by enriching the soil nutrients in the vicinity of the camp. A campsite is therefore the place where forest resources are consumed, and at the same time regenerated.

The materials in the soil are thus circulating in the forest ecosystem, absorbed by the plants from the soil, then returned to the soil through human consumption. And, Human activities and habitation play a role in this circulating process.

Such forest campsites are situated at intervals of three to six km in a hunting territory, which ranges from 150 to 250 km² (Fig. 1) The Mbuti move from one camp to another every two weeks to two months in the hunting season (Ichikawa, 1978). Sometimes a new camp is established in the forest and old ones are abandoned. I observed in one of the Mbuti territories as many as 30 such abandoned old campsites, which had been converted into secondary forest.

Moreover, some Mbuti even shifted their territory over a long distance. As reported elsewhere, the Mawanbo band, which I studied, had moved a total of 200 km during the last several decades before reaching to the present site (Ichikawa, 1986).

The traces of these activities, habitation and movements are left extensively in the forest.

However, Mbuti habitation and subsistence activities have imposed only a limited impact. The villagers' agricultural activities have stronger impacts on the forest vegetation, because, In the fields of slash-and-burn agriculture, the original vegetation is mostly removed from the fields.

The villagers' settlements are distributed now along the major roads penetrating the forest from north to south, and west to east. However, before 1930's when

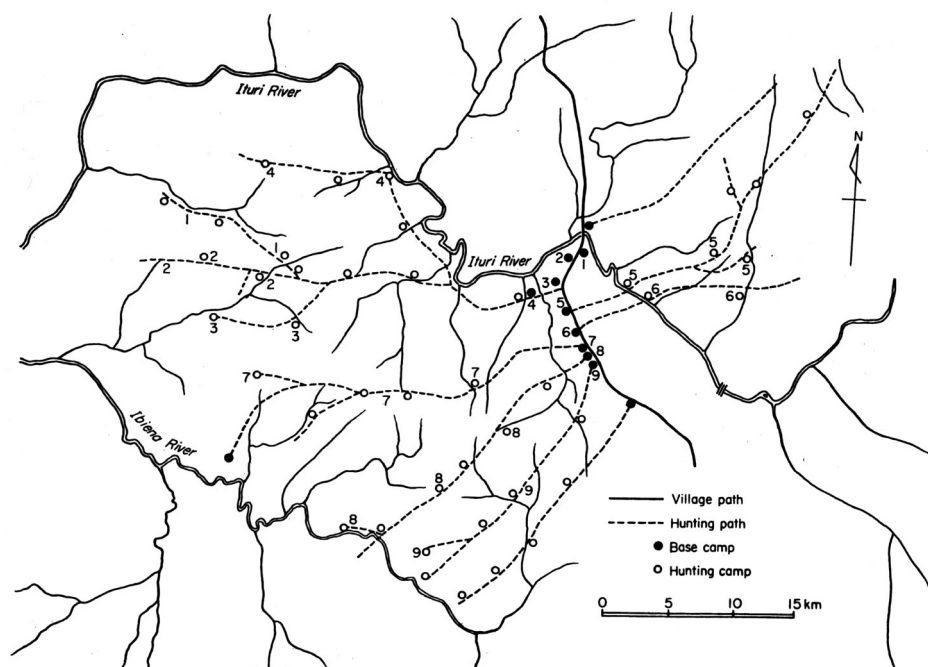


Fig. 1. Distribution of hunting camps in the Teturi area.

these roads were constructed, there had been scattered small villages throughout the forest. The Mbuti distribution was also scattered to these villages where they could get more agricultural food. Particularly in late 19th century, these village sites were frequently shifted in order to escape from the raiding by Arab slave traders (Stanley, 1890)⁽¹⁾. Moreover, in early colonial period, villages were often relocated owing to the re-arrangements of administrative zones and change in the major routes of communication. Father Paul Schebesta, who extensively traveled throughout the Ituri forest, was complaining about this in his book (Schebesta, 1933), saying that the old routes had been quickly covered with thick growth of vegetation.

All these movements and activities had extensive impacts on the forest vegetation.

TRACING THE HUMAN IMPACTS

These old secondary forests could also be distinguished from primary forest by tree composition. The primary forest of Ituri is dominated by evergreen high trees of *Caesalpineaceae*, such as *Cynometra*, *Julbernardia* and *Gilbertiodendron*. The secondary forests, in contrast, are composed of a mixture of trees belonging to

Table 3. Comparison between primary forest and old secondary forest in Ituri.

	primary forest	secondary forest
major tree species	evergreen species dominant Caesalpiniaceae (<i>Cynometra</i> , <i>Julbernardia</i> , and <i>Gilbertiodendron</i>)	more deciduous species Moraceae, Meliaceae, Euphorbiaceae, Ulmaceae
No. of food trees per hectare *	6	13
food trees percent total trees *	1.3	3.3

* : Data from Hart and Hart, 1986

Euphorbiaceae, Moraceae, Meliaceae, Ulmaceae, Sterculiaceae, some of which are deciduous trees. In some areas, there remain oil palm groves that were planted by former inhabitants or grew by themselves from the discarded fruit.

According to Hart and Hart (1986), there are more food trees in the secondary forest than in the primary forest; the former contained 13 trees/ha on the average, compared with only 6 in the latter (Table 3). Moreover, abandoned fields often provide the wild animals with good feeding sites, since there still remain some crops. The Mbuti hunt the animals approaching to these old fields, and exchanged the meat for agricultural food grown by the villagers, who in turn reproduce secondary forest through agricultural activities, while depending on the meat provided by the Mbuti.

Therefore, as the impacts of agricultural activities probably remained moderate until recently, the Ituri forest environment as a human habitat may have been rather improved through the interaction among the Mbuti, villagers and wild animals and plants.

The human impacts may also be found in the faunal composition. While three quarters (75 percent) of 56 mammal species recorded in the Ituri forest is composed of the species of a forest type, some species of savanna origin are also found here, such as Anubis baboons, spotted hyena and cane rats. Also, blue monkeys have their distribution center in east Africa (Fig. 2). These species had probably migrated into the forest through the human-induced secondary vegetation (Itani, 1974).

Thus in the Ituri forest, there are scattered patches of these secondary forest regenerated from abandoned fields, old camp and village sites. We are now trying to analyze the forest environment and its historical changes by using satellite images. In a satellite image, adjustments are made for the colors so that the differences in the vegetation types may appear more clearly. Thus, in the adjusted landsat TM image of the southeastern part of the Ituri Forest, the darker green parts are



Fig. 2. Distribution of “savanna” mammal species found in the Ituri Forest. (Source: modified from Dorst & Dandelot, 1970)

made to represent the dense forest, and reddish part the land with little or no vegetation cover, yellow parts cultivated fields, and yellowish-green parts secondary vegetation (Fig. 3). We can understand from such an image that the Ituri forest shows a very complicated mixture of different vegetation types. The boundaries of different vegetation types are often unclear, and the primary forest (darker parts) is intermingled with the secondary forests (brighter parts) of various succession stages. The overall impression is far from a clear-cut distinction between nature (intact forest) and culture (settlements and agricultural fields). Instead, the “nature” is intermingled with “culture” throughout the Ituri Forest. Such a landscape has been formed through the long-term interaction between man and vegetation in the forest ecosystem.

There are narrow bright yellow and yellowish-green strips along the major roads penetrating the forest, which suggests most of the area along the roads has been converted into cultivated fields and secondary forest. This conforms our knowledge that forest destruction generally occurs first along the major roads. What is more striking in this image is, however, the circular area in the southeast corner where the vegetation cover has been considerably thinned. A close-up of this area (Fig. 4) shows that it is composed of small dots of brown, yellow, and yellowish-green, which probably represents newly opened fields, planted fields and secondary forest, respectively. Therefore, we can see that the forest destruction in this circular area is caused by slash-and-burn cultivation, probably by the immigrants from the densely populated hill country to the east of the Ituri Forest.

What is particularly interesting to the present study is that we can see some historical evidences in this satellite image. The former villages, roads and plantation sites, which were recently abandoned, can be identified as such in the satellite images (Fig. 5). Larger settlements, such as old missionary site or government posts, could be identified in the satellite image even after several decades from its abandonment. For example, Mawambi on the bank of Ituri river had once nearly 1,000 inhabitants and served as important government post until the first half of the twentieth century (Powell-Cotton, 1907; Johnston, 1908)⁽²⁾. The location and extent of Mawambi post are clearly discernible in the satellite image.

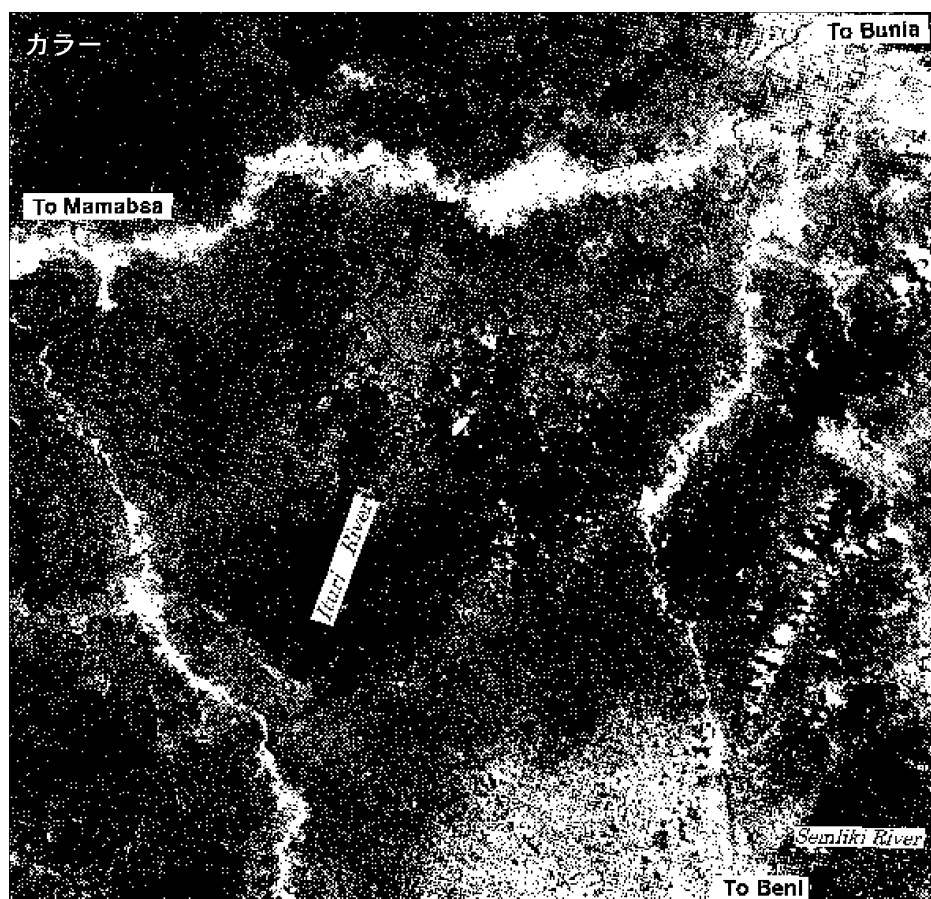


Fig. 3. Satellite TM image of the southeastern part of the Ituri Forest.

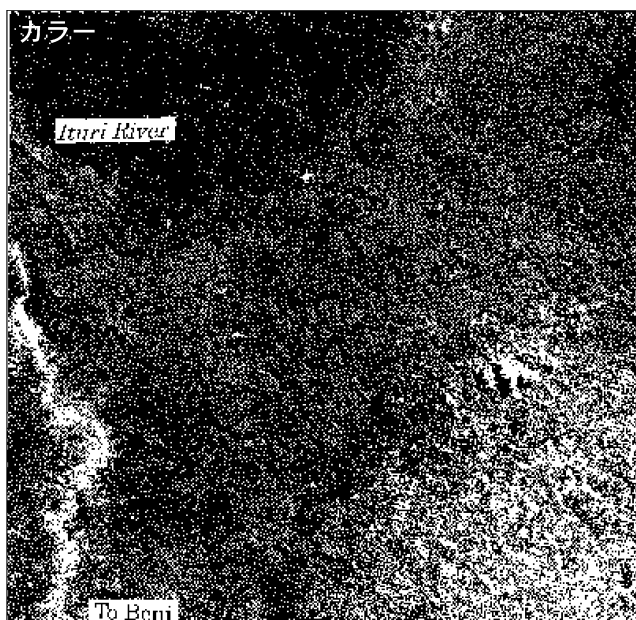


Fig. 4. Expansion of shifting cultivation in the southeastern part of Ituri.

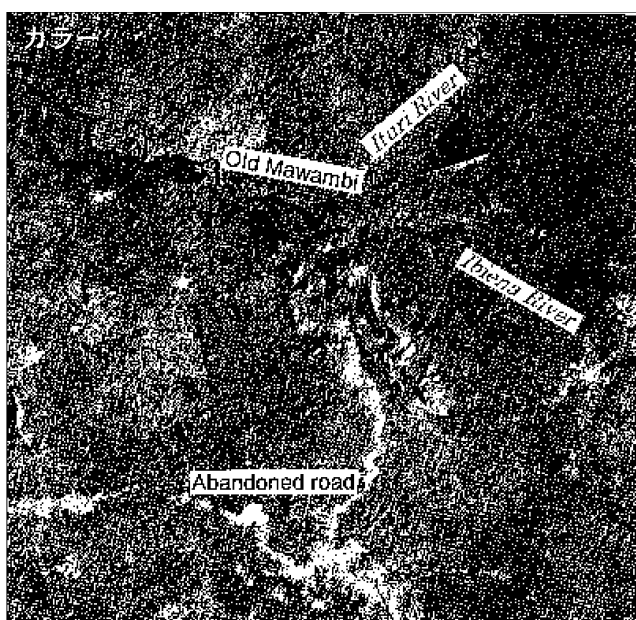


Fig. 5. Former settlements and roads converted to secondary forests in the Ituri-Ibiena confluence.

Satellite images may thus provide us with the information on the extent of human traces in the forest, which could not be obtained easily through the ground survey.

CONCLUSION

What I wanted to say is that the people in the forest, Mbuti in particular, are not merely benefited from the forest, nor are they destroying the forest ecosystem. They comprise in a sense a part of the forest ecosystem and have contributed to maintaining it through facilitating the circulation of the resources and materials in the forest. The plants absorb the nutrients from the soil, and the nutrients accumulated in the plants are concentrated to their settlements and returned again to the soil by the Mbuti activities and habitation in the forest.

Therefore, in dealing with the problems of conservation, the ecological roles they have been playing for centuries should be taken into consideration. Their rights to the land, right to the resources and right of residence in the forest, are of course important. However, as a basis for these rights, we should appreciate their ecological roles in the historical interactions with the forest.

NOTES

- (1) Stanley and his team of Emin Pasha relief expedition certainly found difficulty in locating villages in the Ituri Forest to acquire food, particularly around the area which they called "hungry camp." However, there are many villages indicated in the old maps published in the beginning of the 20th century.
- (2) Mawanbi had been listed in the "Villes, Villages et Localites diverses" section of "Annuaire de Congo-Belge" as an commercial and agricultural center and as "ancien centre d'occupation" until 1935, after which its name disappeared from the list of major villages in the Annuaire.

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——— Accepted September 25, 2000

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